Curriculum RP-51
8000-65-1710

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373.19097713
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DEPARTMENT OF EDUCATION

# CHEMISTRY

AN OPTIONAL COURSE FOR GRADE 11 OR GRADE 12
OF
THE FOUR-YEAR PROGRAM

*This course is experimental in that it will be subject to review.*
*Suggestions for improvement will be welcomed.*

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# CHEMISTRY

## Grade 11 or Grade 12

## Four-Year Program

1. This course is planned as a one-year course for Grade 11 or Grade 12 of the Four-Year Program in the Arts and Science Branch and in the Business and Commerce Branch. By a careful selection of optional units, it could also be used for the Four-Year Program in Science, Technology, and Trades, as an alternative to the course outlined in Curriculum RP-17.

2. The course consists of a core of nine units of basic chemistry followed by several optional units. The first nine units, to be taught to all classes, are planned to take somewhat over one-half of the school year.

   The rest of the school year should be devoted to the teaching of at least three optional units, chosen to meet the needs and interests of the community. These units may be selected from Section II of the course outline, or they may be developed by the teacher under such headings as organic chemistry, cosmetic chemistry, surface coatings (paints), wood chemistry, kitchen chemistry(oven cleaning, detergents, cake baking, etc.)

3. Wherever possible, the scientific principles should be derived from the results of experiments performed by the class. The few experiments that are marked as demonstrations are so marked for reasons of safety in the laboratory or because they require the use of equipment not usually available for use by all of the students. It is possible that the demonstrations could be replaced or reinforced by judicious selection from among the many excellent films now available for the teaching of chemistry.

   Wherever possible, the teacher should use the results of the students' experiments as the basis for the lessons involving discussion of theory. Although the experiments of a given unit are grouped together in the course outline, it is expected that they will be performed at intervals during the development of the topic so that they will provide the desired contribution to the learning process.

4. Since it is possible for a student to proceed through the Four-Year Program in either the Arts and Science Branch or the Business and Commerce Branch without taking Grade 10 Science or Grade 11 Physics, the teacher of this course must not assume that his students come to him with a knowledge of the content of these courses.

5. Because of the wide choice of optional units in this course, it is unlikely that the teacher will find that one textbook adequately covers all of the units of the course. The textbook should be supplemented by desk sets of other books for the teaching of the optional topics. (See Curriculum RP-17, page 4.)

Optional units dealing with industrial processes can often be taught most effectively by using materials and pamphlets available from the industry being studied. In addition to the material to be found in the standard chemistry reference texts, much valuable information is given in the standard encyclopedias. Another very valuable source is A SOURCEBOOK FOR THE PHYSICAL SCIENCES by Joseph et al., published by Harcourt, Brace and World, Incorporated. This is referred to several times in the optional units.

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## SECTION I: COMPULSORY UNITS

### UNIT 1: INTRODUCTION TO THE STUDY OF CHEMISTRY

1. The importance of Chemistry

2. The scientific method

### UNIT 2: MATTER

1. Review of the characteristics of matter

2. States of matter - a comparison of the properties of solids, liquids, and gases illustrated by an experiment such as dropping a piece of dry ice into a beaker of water

3. Properties of matter
   (a) Physical properties
      (i) colour, odour, lustre, hardness, density, structure (crystalline or amorphous), state (under specific conditions), boiling point, freezing point, conductivity of heat and electricity
      (ii) the nature of physical change
      (iii) the separation of substances in a mixture using knowledge of physical properties

   (b) Chemical properties - the nature of chemical change, stressing the concept of chemistry as the transformation of pure substances by the rearrangement of atoms

   (c) (i) differences in physical properties of reactants and resultants
      (ii) release or absorption of energy

   (d) Experiments related to physical properties
      (i) the melting point and the boiling point of substances
      (ii) the separation of the phases in mixtures, e.g., sand and magnetite (or iron filings), clay and water, zinc and sulphur
      (iii) the removal of chlorophyll from leaves (demonstration)

   (e) Experiments related to chemical properties
      (i) the heating of fine iron wire and platinum wire
      (ii) the burning of a candle
      (iii) heating copper wire in sulphur vapour (demonstration)

4. Classification of matter (homogeneous and heterogeneous, mixtures and solutions, elements and compounds) with observation of examples The comparison of mixtures, solutions, and compounds with special reference to variability of composition

5. Elements and symbols of a few common elements

## UNIT 3: THE STRUCTURE OF THE ATOM

1. A brief historical outline of some of the major contributions made in the development of the theory of atomic structure, e.g., origin of name (Democritus), atomic theory (Dalton), electron (Thomson, Milliken), radioactivity (Becquerel, Curies), nuclear atom (Rutherford), protons (Goldstein, Rutherford), arrangement of electrons (Bohr; the value of the concept of the Bohr atom; reason for major modification), neutrons (Chadwick), isotopes (Soddy, Aston, Urey)

2. Atomic Structure
   (a) comparison of protons, neutrons, and electrons as to mass, charge, location of electrons in energy levels
   (b) mass number and atomic number
   (c) electrons and their arrangement
      (i) energy levels K L M N (1-20)
      (ii) existence of electrons in orbitals
      (iii) one or two (no more) electrons in one orbital
   (d) drawing of diagrams of atoms of elements 1-20, given mass number and atomic number, showing nuclei and electrons in their respective energy levels as single or paired dots (as in valence electrons of Lewis structures)

3. Similarities and differences of isotopes in
   (a) structure
   (b) physical and chemical properties, e.g., hydrogen, carbon

4. Atomic Weights
   (a) as the weighted average of the masses of the isotopes of the element expressed in a.m.u. (Atomic Mass Units)
   (b) meaning of a.m.u. as 1/12 of the mass of most abundant isotope of carbon, C-12

## UNIT 4: CHEMICAL COMBINATIONS

1. Valence Electrons

2. (a) Electrovalence and the formation of electrovalent (ionic) compounds
      (i) formation of ions by the transfer of electrons from the outer (valence) shell of an atom of one element (metal) to the outer shell of an atom of another element (non-metal) to attain the stable configuration of the inert gases
      (ii) bonding of ions to form crystalline compounds
      (iii) natural occurrence of elements in ionic compounds as ions

   (b) Experiments related to electrovalence
      (i) demonstration of the formation of sodium chloride from metallic sodium and chlorine
      (ii) formation of magnesium oxide from magnesium and oxygen

3. Covalence and the Formation of Molecules
   (a) the sharing of electrons in pairs by two or more atoms of the same element and of different elements to attain the stable configuration of the inert gases
   (b) the covalent bond
   (c) construction of molecules of simple elements and compounds using plasticine or styrofoam balls or molecular model kits, e.g., hydrogen, oxygen, chlorine, methane, methyl chloride, ethylene, acetylene, ammonia

4. Common radicals as aggregates of atoms linked by covalent bonds which exist as compounds ions, e.g., chlorate, nitrate, carbonate, sulphate, phosphate

5. Writing of Formulas of Commoun Compounds
   (a) using lists of symbols and formulas showing valence
   (b) naming of compounds including the use of suffixes 'ide' and 'ate' in simple salts
   (c) choice of order in naming and formulas, e.g., NaCl, not ClNa

   Note:
   (i) The naming of acids and bases may be included or it may be deferred to Unit 9: Acids, Bases, and Salts.
   (ii) The interest and capability of the students in the group should be considered in determining the depth of treatment of this topic.

## UNIT 5: SOME CHEMICAL REACTIONS

This unit is similar to Unit III, Section 3 of the Grade 9 course and Unit VIII, Section 3 of the Grade 10 course. The length of time spent on this topic should be determined by the amount of science covered by the class in these grades.

1. Oxygen
   (a) the discovery, occurrence, and importance of oxygen
   (b) comparison of industrial production and laboratory preparation of oxygen
   (c) uses
   (d) Experiments to illustrate
      (i) physical properties
      (ii) chemical properties of oxygen and oxides
      (iii) test for oxygen
      (iv) combustion and kindling temperature
      (v) relationship between surface area and rate of combustion
      (vi) the nature of flames

(e) Further Experiments, e.g.,
- (i) preparation of oxygen by the heating of a mixture of potassium chlorate and manganese dioxide
  test for oxygen (review)
- (ii) electrolysis of water
- (iii) combustion in oxygen of sodium, sulphur, carbon, hydrogen, and iron
- (iv) extinguishing a candle flame by closing off the oxygen supply and by the cooling effect of a coil of copper wire conducting heat away from a flame
- (v) dust explosions (demonstration)
- (vi) demonstration of spontaneous combustion using a solution of phosphorus in carbon disulphide on a properly supported filter paper
- (vii) study of a candle flame (review)
- (viii) study of a flame of a Bunsen burner (review)

2. Hydrogen
   (a) The discovery and occurrence of hydrogen
   (b) Commercial preparation (electrolysis of water)
   (c) Uses
   (d) Experiments, e.g.,
   - (i) action of calcium and magnesium with cold water
   - (ii) action of calcium and magnesium with dilute hydrochloric acid
   - (iii) action of sodium with cold water
   - (iv) burning magnesium in steam
   - (v) preparation, collection, and properties of hydrogen using zinc and dilute sulphuric acid
   - (vi) test for hydrogen

Note:
This unit should include the use of atomic theory to explain the phenomena wherever applicable, e.g., the formation of ions, $Zn^{o}$ to $Zn^{2+}$, and the formation of atoms, $H^{+}$ to $H^{o}$.

## UNIT 6: CHEMICAL EQUATIONS

1. Writing chemical equations

   (a) Word equations, e.g., hydrogen + oxygen $\longrightarrow$ water

   (b) Skeleton equations, e.g., $H_2 + O_2 \longrightarrow H_2O$

   (c) Balanced equations, e.g., $2H_2 + O_2 \longrightarrow 2H_2O$

2. Types of reactions

   (a) Combination reactions, e.g., $CO_2 + H_2O \longrightarrow H_2CO_3$

(b) Decomposition reactions, e.g., $2\ KClO_3 \longrightarrow 2\ KCl + 3O_2$

(c) Displacement reactions, e.g., $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

or $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$

Note:
(i) The solving of problems involving equations is optional.
(ii) See the Optional Unit J: Chemical Arithmetic.

## UNIT 7: SOLUTIONS

1. Experiments to illustrate the characteristics of solutions, e.g.,
   (a) preparation of an aqueous solution of copper(II) sulphate noting particularly the significance of uniformity of the colour and the increase in intensity of colour as more solute is added
   (b) an experiment to note the uniformity of sweetness of a sugar solution by the withdrawal of samples from different regions of the solution using a pipette or eye dropper
   (c) examination of samples of solutions and mechanical mixtures using a magnifying glass

2. Experiments to illustrate the factors affecting the rate of solution,e.g.,
   (a) the use of a common solute such as copper(II) sulphate to illustrate the effect of surface area, agitation, and temperature on the rate of solution in water

3. Experiments to illustrate the factors affecting solubility, e.g.,
   (a) the use of water, alcohol, and carbon tetrachloride as solvents for particular solutes such as sodium chloride, iodine crystals, and grease
   (b) the effect of temperature on the solubility of a common solute such as copper(II) sulphate in water
   (c) the effect of pressure on the solubility of carbon dioxide in water
   (d) the effect of temperature on the solubility of air in water

4. Experiments to illustrate the preparation and identification of solutions of different concentrations, e.g.,
   (a) the preparation of an unsaturated and a saturated solution of copper(II) sulphate (An additional crystal of the solute may be added to these solutions before stoppering in order to verify the relative concentration of the solutions.)
   (b) the preparation and testing of a supersaturated solution (A solute such as sodium acetate may be used.)

5. Experiments to illustrate the effect of the solute on the properties of the solvent, e.g.,
   (a) comparison of the boiling points of pure water and of a brine solution
   (b) comparison of the freezing points of pure water and of a brine solution

6. Experiments to illustrate the separation of the components of a solution, e.g.,
   (a) demonstration experiment to illustrate the process of distillation (review)
   (b) demonstration experiment to illustrate the process of fractional distillation

## UNIT 8: IONIZATION

1. Experiments
   (a) to distinguish electrolytes from non-electrolytes, e.g., the relative conductance of distilled water, tap water, and dilute aqueous solutions of alcohol, sugar, and some common acids, bases, and salts
   (b) to distinguish strong electrolytes from weak electrolytes
   (c) to show the effect of dilution on the degree of ionization as indicated by conductance, e.g., of glacial acetic acid
   (d) electrolysis, e.g., of copper(II) chloride
   (e) to show reactions of ions in aqueous solutions, e.g., addition of silver nitrate solution to solutions of different chlorides

2. Meaning of the terms: electrode, cathode, anode, electrolysis

3. Commercial importance of electrolysis

## UNIT 9: ACIDS, BASES, AND SALTS

1. Acids
   (a) Experiments to illustrate the properties of acids, e.g., the addition of common dilute acids to indicators, metals, carbonates, and bicarbonates
   (b) explanation of properties common to acids due to the presence of common hydrogen ion formed by ionization of the solute
   (c) formulas and names of ions in acidic solutions
   names of common acids
   (d) review of formation of acids by the solution of oxides of non-metallic elements in water

2. Bases
   (a) Experiments to illustrate the properties of bases, e.g., the addition of common dilute bases to indicators, metals, carbonates, and bicarbonates
   (b) explanation of the properties of bases due to the presence of the common hydroxide ion
   (c) formulas and names of ions in basic solutions
   (d) review of the formation of basic solutions by the solution of oxides of metallic elements

3. (a) Classification of several commonly-used materials as acidic or basic
   (b) Experiments: testing of common household materials with an indicator, e.g., soap, lye, vinegar, solution of ammonia, lemon juice, orange juice, household cleaners, shampoos, alcohol, sugar

4. (a) Indicators in the home
   (b) Experiments: the addition of (i) dilute acid, (ii) dilute base, to substances such as blueberry juice, beet juice, tea, agarol, red cabbage juice

5. Neutralization
   (a) Experiment: the addition of hydrochloric acid to a solution of sodium hydroxide followed by evaporation to dryness
   (b) explanation of neutralization as the removal of both hydrogen ion and the hydroxide ion from aqueous solutions
   (c) a discussion of the preparation of several salts by neutralization and evaporation

## SECTION II: OPTIONAL UNITS
(At least three to be chosen)

Note: Close examination of the optional units will reveal some overlapping of subject matter. If the teacher chooses two or more optional units containing some similar subject matter, he must ensure that his course outline contains no needless repetition.

## OPTIONAL UNIT A: METALS

1. Occurrence in the earth's crust
   (a) Experiments
      (i) review the reaction between copper and sulphur vapour
      (ii) precipitation of ZnS, PbS, $As_2S_3$, AgCl
      (iii) precipitation of $CaCO_3$, $MgCO_3$
   (b) occurrence of ions of metals in
      (i) sulphides, e.g., of lead, zinc, copper, iron
      (ii) oxides, e.g., of iron, aluminium, tin
      (iii) carbonates, e.g., of calcium, magnesium, barium
   (c) occurrence in the native state: gold, silver, copper
   (d) use of a display of metals and the ores of common metals

2. The Precambrian Shield: a brief history including explanation of its potential as a source of metals

3. Ionization potential of common metals including a comparison of the properties of metals and ions of metals

4. Properties of metals
   (a) Experiments
      (i) displacement of hydrogen from water by sodium, potassium, calcium, copper (negative result)
      (ii) displacement of hydrogen from hydrochloric acid by magnesium, aluminium, iron, copper (negative result)
      (iii) heating of metals in air or oxygen, e.g., magnesium, iron, copper, platinum

(iv) displacement of ions of some metals by other metals
(v) exposure to air (or oxygen) of each of the following metals with attention to rate of oxidation: sodium, copper, iron

(b) Chemical properties with explanations (including the concept of electron change)
(c) Physical properties common to metals including reference to the metallic bond as an explanation of properties: lustre, malleability, ductility, conductivity of heat and electricity

References

Encyclopedia Britannica
A Sourcebook for the Physical Sciences - Joseph et al. (Harcourt, Brace and World)
N.S.T.A. - Vistas of Science 9, Metals, Atoms, and Alloys - McCabe and Bauer (Scholastic Book Services)
Metals in the Service of Man - Alexander and Street (Pelican A125)

## OPTIONAL UNIT B: METALLURGY

1. Experiments
   (a) roasting of copper sulphide or copper carbonate
   (b) reduction of copper oxide by charcoal

2. Production of metals
   (a) Function of common metallurgical processes, e.g., powdering, concentration, roasting, reduction, and purification
   Reference to change from ions to atoms by electron change
   (b) Iron and steel
      (i) the blast furnace
      (ii) the open-hearth furnace
      (iii) the oxygen process
   (c) Other metals, e.g., aluminium, copper, nickel, zinc

References

Encyclopedia Britannica
A Sourcebook for the Physical Sciences - Joseph et al. (Harcourt, Brace and World)
N.S.T.A. - Vistas of Science 9, Metals, Atoms, and Alloys - McCabe and Bauer (Scholastic Book Services)
Teaching Aids available from: Canadian Institute of Steel Construction
388 Yonge Street, Toronto 1

## OPTIONAL UNIT C: ALLOYS

1. Experiments
   (a) determination of the melting point of Wood's metal, including a comparison with the melting points of the metals of which it is made
   (b) comparison of the properties of an iron nail and a steel knitting needle

2. Alloys of iron
   The effects on the properties of the addition of varying quantities of other elements, e.g., manganese, chromium, nickel, silicon
   Uses of common alloys of iron

3. Low melting point alloys and their uses, e.g., Wood's metal, Rose's metal, type metal, solder

4. Alloys of aluminium

5. Some other alloys of interest used in lighter flints, clock pendulums, stove elements, etc.

References

Encyclopedia Britannica
A Sourcebook for the Physical Sciences - Joseph et al.
(Harcourt, Brace and World)
N.S.T.A. - Vistas of Science 9, Metals, Atoms, and Alloys -
McCabe and Bauer (Scholastic Book Services)

## OPTIONAL UNIT D: CORROSION

1. Experiments
   (a) exposure of the following metals to oxygen and/or air for a considerable period of time: iron, stainless steel, galvanized iron, a piece of tin can, aluminium, magnesium
   (b) exposure of a metal to a mixture of oxygen and carbon dioxide for a long period of time
   (c) the effect of touching a silver spoon to a boiled egg
   (d) the effect of corrosion on soldering
   (e) reaction of iron in a solution of copper sulphate
   (f) the effect of an electrolyte on the rate of corrosion of iron, e.g., calcium chloride solution
   (g) galvanic effect (See CHEM Study, Experiment 38)

2. Prevention of corrosion
   (a) Painting, galvanizing, tinning, electroplating
   (b) Use of alloys
   (c) Function of magnesium rods in the corrosion of hot water tanks

3. Corrosion of the metal in the bodies of automobiles
   Importance and consideration of methods of control

4. Self-protective films, e.g., aluminium, magnesium, zinc

References

Encyclopedia Britannica
A Sourcebook for the Physical Sciences - Joseph et al.
(Harcourt, Brace and World)
N.S.T.A. - Vistas of Science 9, Metals, Atoms, and Alloys -
McCabe and Bauer (Scholastic Book Services)
Elements of Science - Spafford and Robinson (Pitman)
CHEM Study: Laboratory Manual, Teachers Guide and Textbook - Chemistry
An Experimental Science (W.H. Freeman and Company)

## OPTIONAL UNIT E: GLASS

1. Experiments
   (a) Preparation of a low melting glass in a crucible from one of the following formulations:
   --2 parts borax to 1 part boric acid (10% silica makes glass of greater durability but higher melting point--1300°C.)
   --30% (bw) PbO to 70% $B_2O_3$
   --72% ZnO to 28% $B_2O_3$ (opal)
   --56% ZnO to 44% $B_2O_3$ (soft opal)
   --90% metaphosphoric acid to 10% PbO (very soft)
   (b) formation of a transparent bead by melting a bit of sodium carbonate on a nichrome wire loop, quickly dipping it into powdered silica and heating it
   Note: Borax and boric acid may be used instead.
   (c) colouring these glass beads by dipping them while still hot into small amounts of cobalt, chromium, or copper oxides, and then reheating
   (d) comparison of the melting of glass and crystalline materials
   (e) the glassy nature of glycerine or rubber cooled to the temperature of dry ice
   (f) comparison of the elasticity and thermal expansion of threads of two different glasses by pulling out threads of the two types of glasses fused in a burner flame
   (g) comparison of the thermal properties of Pyrex with those of other kinds of glass
   (h) demonstration of the principle of safety glass by dipping a test tube into collodion and striking it a blow when dry
   (i) the etching of glass with hydrogen fluoride or hydrofluoric acid (Note: This must be done in a fume hood with good ventilation.)

2. Manufacture
   (a) history
   (b) materials used
   (c) kinds of glass and their applications

3. Properties
   (a) glass as a liquid which has become rigid on cooling without crystallizing, its atoms never arranging themselves into an orderly crystalline pattern
   (b) strength, elasticity, hardness, optical properties, electrical properties, thermal properties, chemical properties, etc.

4. Ceramics

References

Glass Engineering Handbook - Shand
Glass the Miracle Maker - Phillips
Modern Glass Practice - Scholes
A Sourcebook for the Physical Sciences - Joseph et al.
(Harcourt, Brace and World)
Marvels of Industrial Science - Capt. Burr W. Leyson (Dutton)
N.S.T.A. - Vistas of Science 6, Ceramics, Stone Age to Space Age
- Mitchell (Scholastic Book Services)

## OPTIONAL UNIT F: PLASTICS AND RUBBER

Note: The use of molecular models to illustrate the linking of small molecules to form larger ones, cross linking, etc., is advisable.

1. Experiments
   (a) preparation of a condensation polymer such as one of the following:
   --a glyptal resin using glycerol and orthophosphoric acid (CHEM Study, Experiment 29a)
   --an amine-aldehyde type polymer using aniline and formaldeyde (CHEM Study, Experiment 29a)
   --nylon 610 using sebacyl chloride and hexamethylene diamine
   --cellulose acetate using acetic anhydride, sulphuric acid, acetic acid, and absorbent cotton (A Sourcebook for the Physical Sciences, Page 293)
   (b) preparation of an addition polymer such as one of:
   --methyl methacrylate (CHEM Study, Experiment 29a)
   --polystyrene (Polymer Corp.)
   (c) comparison of thermal properties of thermoplastic and thermo-setting polymers
   (d) preparation of an elastomeric polymer (Polymer Corp.)
   (e) experimental study of the elastic properties of a rubber band to illustrate the idea of long molecules coiling and uncoiling: energy changes involved; effect of temperature on elasticity using dry ice and hot water (from "Big Molecules")
   (f) Flame and odour tests for plastics (A Sourcebook for the Physical Sciences, Page 294)

2. The history of rubber and plastics

3. Structure
   (a) composed of giant molecules
   (b) formation of polymers when monomers join in long chains which may be subsequently treated to form cross-links
   (c) condensation and addition polymers

4. Properties
   (a) strength, density, elasticity, optical properties, electrical properties, thermal properties, chemical properties
   (b) thermoplastic and thermosetting plastics
   (c) elastic properties of elastomeric polymers (rubber) related to coiling ability and length of molecule
   (d) Natural rubber compared with synthetic rubbers

5. Kinds and uses, with emphasis on variety

References

CHEM Study: Laboratory Manual, Teachers Guide and the Textbook, Chemistry--An Experimental Science (W.H. Freeman and Company)
A Sourcebook for the Physical Sciences - Joseph et al. (Harcourt, Brace and World)
Big Molecules - Melville (G. Bell & Sons Ltd. - London)

Additional Teaching Aids may be obtained from

Society of the Plastics Industry (Canada) Inc., 660Z Eglinton Avenue East, Toronto 17, Ontario.
Polymer Corporation Limited, Sarnia

## OPTIONAL UNIT G: FUELS

Note: Extensive use of molecular models is desirable in illustrating molecular structure and changes in molecular structure.

1. Experiments
   (a) demonstration of destructive distillation of wood
   (b) demonstration of destructive distillation of coal
   (c) demonstration of fractional distillation (A Sourcebook for the Physical Sciences, Page 280)
   (d) demonstration of catalytic cracking (A Sourcebook for the Physical Sciences, Page 281)

2. Formation of fossil fuels

3. Molecular structure of simple hydrocarbons

4. Composition of petroleum (Have samples available if possible.)

5. Cracking, reforming, and polymerizing as methods of building desirable molecules

6. Petrochemicals--other products of the petroleum industry

7. Calculation of heat cost of various fuels, e.g., in B.T.U. per dollar in the local area

References

Petroleum - Purdy (Copp Clark)
Chemistry and Petroleum - American Petroleum Institute
Physics and Petroleum - American Petroleum Institute
Sourcebook for the Physical Sciences - Joseph et al.
(Harcourt, Brace and World)

## OPTIONAL UNIT H: TEXTILES

Note: The work covered in this unit should be co-ordinated with the Home Economics course to avoid repetition. The experimental work in this unit should provide a valuable complement to the parallel work in Home Economics.

1. Experiments (A Sourcebook for the Physical Sciences, Chapter 15)
   (a) microscopic inspection of various fibres, e.g., cotton, wool, silk, linen, rayon, viscose, acetates
   (b) chemical tests to distinguish between various common fibres
   (c) mercerizing cotton
   (d) preparation of samples of synthetic fibres, e.g,, one of
      (i) nylon using adipic acid and hexamethylenediamine
      (ii) nylon 610 using sebacyl chloride and hexamethylenediamine
      (iii) viscose solution
      (iv) cellulose acetate
   (e) the need for and use of a mordant in dyeing a fabric

2. Discussion of the structure, properties, and special advantages of various textile materials

3. Discussion of the structural changes and the accompanying changes in properties when certain filaments, e.g., nylon or orlon, are stretched or drawn

References

A Sourcebook for the Physical Sciences - Joseph et al.
(Harcourt, Brace and World)
Also available: A Cotton Chemistry Kit, The Canadian Cotton Council
1466 Crescent Street, Montreal 25, Quebec

## OPTIONAL UNIT J: CHEMICAL ARITHMETIC

1. Experiments
   (a) quantitative decomposition of mercury(II) oxide and the use of the data obtained to determine the formula
   (b) determination of the number of moles of silver produced from a solution of silver nitrate by one mole of copper (verification of chemical equation) (See CHEM Study)

2. Atomic weight, gram-atomic weight

3. Determination of formula from proportion by weight

4. Determination of composition by weight from the formula

5. The use of equations in solving problems concerning weight relationships
   Simple problems on the concentration of solutions

## OPTIONAL UNIT K: GARDENING

1. Elements of soil essential for plant growth

2. Soil analysis
   (a) acidity and alkalinity - Hydrion paper
   (b) the presence in soil of nitrates, phosphates, and potash
   (c) types of fertilizers
      (i) compost hill
      (ii) commercial fertilizers: nitrate, phosphate, and potash content
      (iii) chemical soil conditioners

3. Insectides, Fungicides, and Herbicides

4. Control of Insects

5. Control of Plant Diseases

6. Control of Plant Growth

7. Chemical Gardening: The growing of plants, e.g., tomatoes, coleus, sweet peas, in nutrient solutions (hydroponics)

References

A Sourcebook for the Biological Sciences - Morholt et al. (Harcourt, Brace and World) Chapter 8
Soils - Donahue (Prentice Hall)
Ontario Soils - Bulletin 492, Ontario Department of Agriculture
An Introduction to Physical Science (Chapter 12) - Hedley (Holt, Rinehart and Winston)

## OPTIONAL UNIT L: FOOD CHEMISTRY

1. Experiments
   (a) testing of foods for the various nutrients
   (b) the hydrolysis of sucrose using saliva
   (c) the hydrolysis of sucrose using hydrochloric acid
   (d) the hydrolysis of starch using saliva
   (e) the hydrolysis of starch using hydrochloric acid

2. Types of nutrients in food: carbohydrates, fats, proteins, minerals, vitamins

3. Chief sources of each type of nutrient

4. Uses of each type of nutrient

5. Balanced diet

6. Chemical processes in digestion and the function of the enzymes as catalysts

References

A Sourcebook for the Biological Sciences - Morholt et al.
(Harcourt, Brace and World)
A Sourcebook for the Physical Sciences - Joseph et al.
(Harcourt, Brace and World)
N.S.T.A. - Vistas of Science 10, Nutrition Science and You - Mickelsen
(Scholastic Book Services)

## OPTIONAL UNIT M: COMBUSTION AND FIREFIGHTING

1. Experiments
   (a) review of oxidation, combustion, ignition termperature, and spontaneous combustion (See Curriculum I:1(e), page 60, and Unit V of this course)
   (b) extinguishing of fire, e.g., a candle flame, by cutting off the supply of air or oxygen and by lowering the temperature
   (c) action of the soda-acid type fire extinguisher and the foam-type fire extinguisher

2. Word equations and chemical equations for the reactions studied

3. Putting out fires
   (a) reduction of the temperature below the ignition (kindling) temperature
   (b) the need of oxygen for combustion and the use of smothering agents to separate the fuel from the oxygen supply
   (c) types of fire extinguishers, their uses and limitations
      (i) soda-acid
      (ii) foam type
      (iii) bottled carbon dioxide
      (iv) carbon tetrachloride
      (v) baking soda (a good home fire extinguisher)

References

A Sourcebook for the Physical Sciences - Joseph et al.
(Harcourt, Brace and World) - Chapter 9

## OPTIONAL UNIT N: MINERALS AND MINERAL PRODUCTS

Note: This unit may be limited to a more complete development of the study of the minerals of interest or economic importance in the local area.

1. Experiments
   (a) the action of heat on a hydrate such as bluestone and the action of water on the anhydrous residue
   (b) the conversion of gypsum into plaster of Paris
   (c) the effect of the addition of water to plaster of Paris
   (d) the preparation and properties of quicklime
   (e) the preparation and properties of slaked lime and the action of carbon dioxide on slaked lime
   (f) the preparation and hardening of lime-sand mortar
   (g) the initial set and final hardening of cement

2. Gypsum
   (a) the composition, properties, and uses of gypsum
   (b) a discussion and display of other gypsum products such as wall-board, gypsum blocks, and acoustic materials

3. Limestone
   (a) the composition, properties, and uses of limestone
   (b) uses of slaked lime

4. Cement and concrete
   (a) the composition, properties, and manufacture of cement
   (b) the composition and function of the components of concrete
   the effect of impurities, moisture, temperature, mixing, and concentration of the mix on the quality of the product
   (c) a comparison of the setting of concrete with that of lime-sand mortar
   (d) how to determine quantities for concrete
   (e) the uses of concrete
   (f) recall of the expansion of water on freezing and its application to the disintegration of concrete
   (g) recall of the action of carbonic acid on limestone, and discussion of its similar disintegrating action on the calcium salts in concrete

5. Salt
   (a) occurrence, industrial production, and uses
   (b) physical and chemical properties
   (c) electrolysis of brine and the recognition of the products

6. Economic minerals other than the ores of metals, e.g., flurospar, talc, nepheline syenite, asbestos, sand and gravel, clay and shale
   (a) occurence
   (b) properties
   (c) uses

   Note: For the ores of metals, see Optional Units A and B

References

N.S.T.A. - Vistas of Science 6, Ceramics, Stone Age to Space Age
Mitchell (Scholastic Book Services) (See Chapter 8)

Teaching Aids Available

A collection of 36 mineral chips or 36 rocks, The Geological Survey, 601 Booth Street, Ottawa
A collection of minerals and rocks, Department of Mines, Parliament Buildings, Toronto

## OPTIONAL UNIT O: ELECTROCHEMISTRY

1. Review of the voltaic cell (See Curriculum I:1(e), page 59)

2. Experiments
   (a) the zinc-carbon-ammonium chloride cell
   (b) to improvise a dry cell using carbon, zinc, and filter paper soaked in ammonium chloride solution
   comparison with a commercial dry cell (Sourcebook, page 258)
   (c) a lead storage cell (Sourcebook, page 258-260)
   comparison with one cell of a storage battery
   (d) electrolysis of water (Sourcebook, page 132-134)
   (e) (demonstration) the electrolysis of brine (Sourcebook, page 232)
   (f) electroplating (Sourcebook, page 260-262)

References

A Sourcebook for the Physical Sciences - Joseph et al.
(Harcourt, Brace and World)

## OPTIONAL UNIT P: AIR POLLUTION

1. Experiments to detect, measure, and remove air pollution
   (a) dustfall using the fall-out rub test (See ref. Appendix 305)
   (b) sulphur dioxide using the lead peroxide method
   (c) pollen count
   (d) reading visible omissions using a Ringelmann Smoke Chart
   (e) building of an electrostatic precipitator
   (f) Brownian movement

2. Composition of clean dry air
   (a) a review of the relative abundance of the principal gases found in "clean" dry air
   (b) factors affecting the quantity of these gases in the atmosphere
   (c) the properties and uses of these gases

3. Colloidal Suspensions

4. Causes and Effects of Air Pollution
   (a) causes: contributions to the pollution of air by such devices as automobiles, oil burners, industrial heating units, locomotives, incinerators, various industrial processes and natural pollution-causing factors
   (b) effects on vegetation, cattle, building materials, clothing, surface finishes, and human health

5. The Classification of Air Contaminants
   The grouping of the contaminants commonly produced by industrial processes as organic gases, inorganic gases, and aerosols

6. Industrial Air Pollution Control Devices
   The use of centrifugal collectors, electrical precipitators, cloth filters, and wet collectors to remove contaminants

7. Allergic Reactions from Air Contaminants
   (a) plants producing harmful pollen and the method of reducing pollen abundance
   (b) other contaminants which cause allergic reactions

References

1. A number of articles have been released free of charge by the Municipality of Metropolitan Toronto Department of Works - Air Pollution Control. The releases of particular relevance to this course include the following:

   (a) Introductory Material

| Number | Title |
|---|---|
| R - 5 | Air Pollution, Its Causes and Effects |
| R - 12 | Public Health's Viewpoint |
| R - 206 | The Filthy Air We Breathe |
| R - 205 | Tomorrow Is Already Here |
| R - 19 | We Are Poisoning the Air |
| R - 13 | Planning and Zoning |
| R - 16 | Slogans |
| R - 15 | Educational |

   (b) Control of Contaminants

| | |
|---|---|
| Appendix - U | Leaf Burning and Open Fires |
| Appendix - 120 | Industrial Air Pollution Control |
| Appendix - 103 | Maximum Levels of Air Pollution in California |

| | | |
|---|---|---|
| Appendix - | 122 | Air-Pollution Controls for Aerosols |
| R - | 531 | The Removal of Sulphur Pollution |
| Appendix - | 130 | Control of Fumes from Paint and Varnish Manufacturing |
| R - | 7 | The Ragweed Story |
| R - | 11 | What Can Be Done About Ragweed Pollen - Hayfever and Asthma |

(c) Measuring Contamination

| | | |
|---|---|---|
| R - | 6 | Pollen Terminology and Pollution Limits |
| Appendix - | 3 | Recommended Practice for Planning the Sampling of the Atmosphere |
| Appendix - | 305 | Fall-out Rub Test |
| Appendix - | 102 | Conversion Factors |
| Appendix - | 110 | Characteristics of Fine Particles |
| Appendix - | 735-4 | Dustfall, Data Chart from Testing Stations in Metropolitan Toronto |
| Appendix - | 736-4 | Soiling Indices Data Chart for Average Monthly COH Units from Testing Stations in Metropolitan Toronto |
| Appendix - | 739-3 | Atmospheric $SO_2$ Concentrations, Data Chart from Testing Stations in Metropolitan Toronto |
| | | Ringelmann Smoke Chart - small cards for visual estimations |
| (Unclassified) | | Determination of Sulphate in Lead Peroxide Candles (Gravimetric) Approved Method 10-5901 |

2. Additional Sources for information on Measuring Contamination

| | |
|---|---|
| ASTM Standard #D-2010-62T | Evaluation of the Total Sulfation in the Atmosphere by the Lead Peroxide Candle |
| Journal of the Air Pollution Control Association, January 1961, page 24 | Monitoring Sulphur Dioxide with Lead Peroxide Cylinders |

3. Books

| | | |
|---|---|---|
| Air Pollution (2 vol.)..... | A.C. Stearn..... | (Academic Press) |
| Air Pollution Control ..... | W.L. Faith ..... | (John Wiley & Sons, Inc.) |
| Problems and Control of Air Pollution ..... | F.S. Mallette ..... | (Reinhold Publishing Corp.) |
| Air Pollution Handbook ..... | Magill, Holden Ackley | (McGraw-Hill) |
| Guide to Diagnosis of Occupational Diseases ..... | Department of Health for Ontario | |

4. Pamphlets
   (a) Pamphlets available from the U.S. Department of Health, Education and Welfare:
      (i) Air Pollution - A National Problem
      (ii) Troubled Air
   (b) Sulphur Dioxide - An examination of sulphur dioxide as a pollutant
      Available from:
      The National Society for Clean Air,
      Field House, Breams Buildings,
      London, E.C.4,
      England.
   (c) Occupational Health Bulletin
      Available from:
      Occupational Health Division,
      45 Spencer Street,
      Ottawa, Ontario.
      (Vol. 18, number 9, 1963 - has an article on reading visible emissions)

## OPTIONAL UNIT Q: WATER RESOURCES AND THEIR IMPURITIES

1. Experiments
   (a) permanent and temporary hardness
   (b) water softening
   (c) examination of naturally occurring water for impurities by filtration and microscopic examination
   (d) testing water for such contaminants as free ammonia, chlorides, dissolved oxygen, pH, metallic ions

2. The Importance of Water Resources
   A summary of the present and future water requirements
   The inadequacy of available water resources for this increasing need

3. Sources and Nature of Water Contaminants
   Household sewage, industrial wastes, detergents, normal run-off, radio-active wastes

4. Effects of Contaminants
   The effect of contaminants on aquatic plant and animal life
   The effect of this contamination on human life in its various aspects

5. Sewage Treatment
   The treatment by both private industry and municipal governments of industrial wastes and sewage

References

A number of general pamphlets can be obtained from the Ontario Water Resources Commission, Toronto, Ontario, such as the following:

The Story of Water
Physiology of Microorganisms Relating to Waste Stabilization Lagoons
The Importance of Water